COGNITION IN SOCIAL CONTEXT

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ABSTRACT: A great deal of research has focused on delineating the nature and extent of sex differences in cognitive abilities and performance. However, recent research and theory suggest that cognition may be much more socially situated than psychology has recognized. Distinguishing "sex" from "gender" places sex difference research in a context that conceives of culturally-produced gender as the operation of a complex system of social classification and hierarchy. The gender system is conceptualized as operating at three levels: Sociocultural, interactional, and individual. By using this framework, we move the focus of study from individual or group differences in cognition to documenting how different levels of the gender system interact to create, maintain, and interpret sex differences.

Sex differences in cognitive abilities and performance have long been a staple of psychological research. Efforts have focused on delineating the nature and extent of differences and documenting biological and social influences on their occurrence and magnitude. In this paper, we shift the focus from sex to gender. We place the topic of sex differences in cognition within a framework that conceives of gender as a system of meanings that organizes relations of power and status. This framework is a means of expanding understanding of how both immediate situations and larger cultural contexts produce and maintain sex differences. Its use will aid in examining issues of sex differences and social policy.

THE SEX/GENDER DISTINCTION

Feminist psychology makes a conceptual distinction between sex and gender (Unger 1979; Crawford & Unger 1994; Unger & Crawford 1996). *Sex* is defined as biological differences in genetic composition and reproductive anatomy and function. *Gender* is what culture makes out of the "raw material" of biological sex. All known societies recognize biological differentiation and use it as the basis for social

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distinctions. In North American society, the process of creating gendered human beings starts at birth. When a baby is born, the presence of a vagina or penis represents sex—but the pink or blue blanket that soon enfolds the baby represents gender. The blanket serves as a cue that this infant is to be treated as a girl or boy, not as a "generic human," from the start. A simple color-code places the infant within a preexisting system of meanings based on biological sex.

Because gender is based on sex, the two terms have sometimes been used interchangeably. However, it is important to distinguish sex from gender for two reasons. First, equating them can lead to the belief that differences in the traits or behaviors of men and women are due directly to their biological differences, when the traits or behaviors actually may be shaped by culture. Secondly, keeping the concepts of sex and gender distinct can help us to analyze the complex ways they interact in our lives. The widespread confusion over the use of these two terms is a testimony to the lack of understanding of the way people are shaped by their society and by dynamics of everyday interactions (Deaux 1993; Gentile 1993; Unger & Crawford 1993).

The influence of gender-based social distinctions is pervasive. Gender-related processes influence behavior, thoughts and feelings in individuals. They affect interactions among individuals; they help determine the structure of social institutions. Gender functions as a cultural classification system in much the same way that other systems such as race, class, and age function. The processes by which differences are created and power is allocated can be understood by considering how gender is played out at three levels: societal, interpersonal, and individual.

THE GENDER SYSTEM

THE SOCIAL STRUCTURAL LEVEL: GENDER AS A SYSTEM OF POWER RELATIONS

In the broadest sense, gender is a classification system that shapes the relations among women and men. For example, virtually all societies label some tasks as "men's" and others as "women's" work. While there is a great deal of variability in tasks assigned to each sex across societies, whatever is labelled "women's work" is usually seen as less important and desirable. Not only women's work but also women themselves are devalued. Gender ideology is disseminated through the representation of gender stereotypes in the mass media, patriarchal structures of family and religion, and continued structuring of the workplace around gender inequality. Thus gender can be viewed as a system of social classification that influences access to power and resources (Crawford & Marecek 1989; Crawford & Unger 1994; Sherif 1982).

THE INTERPERSONAL LEVEL: GENDER AS A CUE

In every society, certain traits, behaviors, and interests are associated with each sex and assumed to be appropriate for people of that sex. Since there are only two sexes, gender is also assumed to be dichotomous: a person can be classified as either "masculine" or "feminine," but not both. Although many traits, interests, behaviors, and even physical characteristics are ascribed to women *or* men, in reality, people often show characteristics ascribed to the other sex. Thus gender, as it is usually framed, reflects a form of stereotyping (Deaux & Major 1987; Unger & Crawford 1996).

Gender stereotypes are brought to bear in social interaction, as people seek to confirm the perceived duality of sex. In interaction, people use gender cues to make inferences about sex, and they use perceived sex to make inferences about gender. They rely on these cues to tell them how to behave toward others. Although much of this sex-differential treatment happens outside awareness, it can be observed in careful laboratory and field studies. For example, observations in primary school classrooms show that, although teachers believe that they are treating boys and girls the same, boys receive more attention, both positive and negative, than girls do. Boys are yelled at and criticized more in front of their classmates. Moreover, it often happens that a few boys are allowed to dominate class time by constant interaction with the teacher, while the majority of students remain silent (Eccles 1989; Sadker & Sadker 1994). The reasons that these gendered interactions occur probably involve a complex mixture of self-perceptions and beliefs about others (both gender-linked), and the behavioral consequences of acting on these beliefs. Gender becomes a self-fulfilling prophecy.

The interactional level has not been well conceptualized with respect to sex differences in cognition. We consider this a crucial omission, and much of this article will be an attempt to develop an understanding of how cognitive categories based on sex as a social cue influence people's behavior and elicit gender-characteristic patterns of interaction. Sociologists, starting with West and Zimmerman (1987), speak of "doing gender," and feminist psychologists are adopting the term to designate how sex is a salient social and cognitive category through which information is filtered, selectively processed, and differentially acted on to produce self-fulfilling prophecies about women and men (Unger & Crawford 1996).

As a preliminary illustration of these processes, we turn to a classic social psychological experiment (Zanna & Pack 1975), which demonstrated the behavioral effects on women of expectations held by attractive men. Eighty women completed questionnaires assessing their level of agreement with 11 traditional (e.g., "I am very sentimental") and nontraditional (e.g., "I am very career-oriented") statements about themselves. Three weeks later, the participants were called back individually to read questionnaires presumably completed by men they would soon meet. Half of the women were to meet a highly desirable man (tall, Ivy League senior with no girlfriend who wanted to meet new women) and the other half were to meet an undesirable man (short, non-Ivy League freshman with a girlfriend who did not want to meet new women). After reading their "partner's" profile, the women

received another form indicating his image of the ideal woman. In the Traditional stereotype condition, the "partner" agreed with statements such as "The ideal woman would be very emotional"; "... very soft"; "... very passive;" and disagreed with statements such as "The ideal women would be very independent"; "... very competitive"; ". . . very dominant." In the Untraditional stereotype condition, responses followed the opposite pattern.

The women then completed a questionnaire which would presumably be shown to the man they had just read about. Included in the questionnaire were the same 11 sex-role stereotypic items they had completed earlier. The women's final task was to complete as many of 50 four-letter anagrams as they could in five minutes. This task, they were told, was a behavioral measure of intellectual ability and their score would be included in the information given to the man they would soon meet.

Results indicated that highly desirable men significantly influenced women's self statements about their level of traditionality in the direction held by those men. In other words, women changed their original responses to the sex-role stereotype items to conform more closely with the views held by a desirable man who would soon read those responses. Further, when paired with a desirable partner who held untraditional sex-role views, women performed significantly better on the anagram test than when the desirable partner held traditional views of women. (Undesirable men had no influence on the women's responses.) When presenting their opinions to a desirable man they believed they would meet, these women modified both their sex-role attitudes and their apparent intellectual ability. Clearly, they were responding to gender-linked social influences which significantly affected their behavior and cognitive performance; they were "doing gender."

"Doing gender" is not exclusively a female domain. Morier and Seroy (1994) replicated Zanna and Pack's (1975) study with male subjects. After completing a questionnaire assessing sex-role attitudes, the men returned two weeks later to read an information sheet about a highly desirable woman (physically fit, attractive student at prestigious college, wanted to meet men) or an undesirable woman (not physically fit, unconcerned about appearance, student at community college, did not want to meet men) they would soon meet. Half of the sex role attitudes presumably reported by these women indicated traditional expectations for men's behavior and half indicated nontraditional expectations for men's behavior. Participants completed a questionnaire for their partner to read which included another report of their own sex-role attitudes.

The pattern of responses given by these men mirrored those given by the women in Zanna and Pack's (1975) study. Men who thought they were about to meet a desirable woman significantly altered their gender role attitudes to conform to their partner's perceived attitudes. The prospect of meeting an undesirable woman had no effect on the men's attitudes. (Unfortunately, Morier and Seroy did not replicate the anagram part of the study.)

These studies show how social actors can create their own social reality. Whether a task is congruent with masculinity or femininity, how the actor wishes to present himself or herself, the perceived costs of violating gender roles—all these can affect

expressed attitudes and cognitive performance. At the *interactional* level, gender is continually enacted, negotiated, and re-created.

THE INDIVIDUAL LEVEL: GENDER AS MASCULINITY AND FEMININITY

To a greater or lesser extent, women and men come to accept gender distinctions visible at the structural level and enacted at the interpersonal level as part of the self-concept (Crawford & Unger 1994; Unger & Crawford 1996). They become *gender-typed*, ascribing to themselves the traits, behaviors, and roles normative for people of their sex in their culture. Women, moreover, internalize their devaluation and subordination. Feminist theories of personality development (e.g., Miller 1976/1986) stress that "feminine" characteristics such as passivity, excessive concern with pleasing others, lack of initiative, and dependency are psychological consequences of subordination. Members of subordinate social groups who adopt such characteristics are considered well adjusted; those who do not are controlled by psychiatric diagnosis, violence or the threat of violence, and social ostracism.

Much of the psychology of women and gender has consisted of documenting the effects of internalized subordination. Laboratory and field research, as well as clinical experience, attest that, compared to boys and men, girls and women lack a sense of personal entitlement (Apfelbaum 1986; Major, McFarlin, & Gagnon 1984), pay themselves less for comparable work (Major & Deaux 1982), are equally satisfied with their employment, even though they are paid significantly less than men (Crosby 1982), lose self-esteem and confidence in their academic ability, especially in mathematics and science, as they progress through the educational system (Chipman & Wilson 1985; Eccles, Adler, Futterman, Goff, Kaczala, Meece, & Midgley 1985) and are more likely to suffer from disturbances of body image, eating disorders, and depression (McGrath, Keita, Strickland, & Russo 1990; McCaulay, Mintz, & Glenn 1988; Hesse-Biber 1989).

Gender at the social structural level has traditionally been the province of sociology and anthropology, while the interactional level has been encompassed by social psychology and the individual level by clinical, developmental, and personality psychology. In studying women and gender it is necessary to focus on one level while keeping sight of the system as a whole. Just as clinicians who treat the effects of internalized subordination must conceptualize and respond to structural aspects of clients' problems, researchers in the psychology of gender must place their work in the context of gendered social structures. Both clinicians and researchers share conceptual and methodological concerns with those attempting to understand other systems of social classification such as age, "race," and class (Brown & Root 1990).

An advantage of a gender system approach is that it holds the promise of providing an explanation of how gender differences are socially produced and maintained, rather than simply describing them. We will focus on two areas of difference which have attracted the most attention, spatial and mathematics ability, and on two types of explanation: the effect of gendered expectations on performance (illustrating the interactional level), and differences in experience (illustrating effects of individual and structural levels of gender). It is not that we believe that the

particular influences we describe are the only sources of sex differences. Rather, studies of this type serve to illustrate that differences must be looked at in terms of the whole gender system, not only at the individual level.

SPATIAL ABILITIES

Spatial abilities involve perceiving and mentally manipulating shapes and images. They are useful in doing certain kinds of mathematics, in jobs such as architecture, and in everyday tasks such as sewing a dress or building a model from a pattern, doing jigsaw puzzles, or envisioning how furniture would fit into different arrangements in a room. Sex differences in spatial ability are among the largest and most reliable of cognitive sex differences. Starting in elementary school, boys score higher on tests of spatial perception and mental rotation but not spatial visualization (Linn & Peterson 1986). It is not uncommon to hear scientifically sophisticated people cite sex differences in spatial ability as a reason or justification for why there are so few women engineers, pilots, architects, mathematicians, and so on. When these differences are seen from a the wider perspective of the gender system, such conclusions seem much less compelling. First, we will briefly review evidence for a sex difference in spatial ability. We will then consider some possible sources of these differences in the gender system.

Narrative reviews have generally concluded that there are gender-related differences in spatial ability, favoring males, which first emerge in adolescence (McGhee 1979; Maccoby & Jacklin 1974; Meece, Parsons, Kaczala, Goff, & Futterman 1982). But this area, perhaps more than any other, illustrates the complexity of issues in research on gender-related differences. First, there is little agreement on a definition for the term spatial ability. While some researchers see it as a unitary construct, others argue that is composed of varying numbers of subskills (Halpern 1992) and still others argue that it is so ill-defined that it is useless as a psychological concept (Caplan, MacPherson, & Tobin 1985). There are hundreds of tests that attempt to measure spatial ability, and it is not always clear how they can be grouped or compared to each other. On some tests, females' scores are more variable than males', and on others the reverse is true. To add to the confusion, there has been disagreement over the age at which differences first emerge and inconsistencies in the pattern and size of differences across age groups (Unger & Crawford 1996).

Today, the most reliable conclusions about gender-related differences in spatial abilities (as well as other cognitive abilities) can be drawn from two sources. The first is meta-analyses of the literature. The second is the norms for standardized psychometric tests. Large numbers of people take tests such as the Differential Aptitude Test every year. Their norms are valuable to the researcher because they are based on representative samples and involve minimal publication bias, since both similarities and differences between male and female test-takers are published

(Burnett 1986). However, it should be noted that test norms use such enormous samples that even tiny differences are likely to be statistically significant.

Linn and Petersen (1985, 1986) conducted a meta-analysis of spatial ability experiments, classifying tasks into three categories. In spatial-perception tasks, the test-taker must locate the horizontal or vertical in a visual field in spite of distracting information. One much-studied example is the rod-and-frame test (Witkin, Dyk, Faterson, Goodenough, & Karp 1962). Mental-rotation tasks involve the ability to imagine how a two- or three-dimensional figure would appear if rotated in space. Finally, spatial-visualization tasks require complex analysis of the relationships between different spatial representations. Examples include the embedded figures, hidden figures, and block design tests.

Linn and Petersen (1985) reported that starting in elementary school boys score higher on tests of spatial perception and mental rotation. The differences are larger for adults than for children and, for mental rotation, are highly task-dependent—in other words, some mental rotation tasks reliably show large gender-related differences and others do not. On the more complex spatial-visualization tasks, which may require both mental rotation and spatial perception as well as analytic strategies for their solution, there were no gender-related differences at any age. The results of national standardized tests of spatial visualization still show a small gender-related difference, but it has declined by 59% in the past 40 years (Feingold 1988).

FACTORS INFLUENCING SPATIAL ABILITIES

Gendered Expectations about Spatial Abilities. Most of the gender-related difference in spatial abilities may be due to sociocultural factors. People in our society believe that large sex differences exist and that spatial skills are "masculine." For example, in a meta-memory study of beliefs about women's and men's memory abilities (Crawford, Herrmann, Holdsworth, Randall, & Robbins 1989), participants rated how well women in general, men in general, and they themselves could remember various types of information (e.g., names, places, directions, shopping lists, conversations). Men and women agreed that men are better at finding previously visited places and directions (spatial tasks), and women are better at remembering shopping lists and names (verbal tasks). Ratings of one's own abilities followed divergent patterns from the ratings of women and men in general.

This study demonstrates that men and women hold similar views about the ability of each sex to remember various types of information. The pattern of items each sex was thought to remember best followed traditional sex role expectations: men were perceived as better at remembering spatial tasks such as directions and finding places while women were rated higher on verbal/relational tasks such as remembering names, faces, and conversations.

Beliefs about cognitive abilities affect performance on tests of these abilities. Simply changing the instructions or the name of a task can elicit or eliminate sex differences in some tasks. Herrmann, Crawford, and Holdsworth (1992) asked

female and male participants to perform two memory tasks, remembering a list of items and a set of instructions. They manipulated the gender label of the task while keeping task requirements constant. The list was entitled "Grocery store list" or "Hardware store list" and contained items such as brush, hose, chips, nuts, and salt. The instructions were labelled either "Making a shirt" or "Making a workbench" and contained neutral phrases such as "Rearrange the pieces into different groups," "Get the necessary tools and implements," "Find the corresponding parts," and "Follow the diagram and directions."

In both the list and the directions task, men remembered the male gender-typed set better than women did, and women remembered the female gender-typed set better than men. Additionally, men were more affected by the gender-typing than women. They performed significantly worse on the female gender-typed tasks of remembering the grocery store list and constructing a shirt, while women performed only marginally worse on the male gender-typed tasks of the hardware store list and the workbench directions. One possible explanation for this phenomenon is that masculinity is more narrowly defined than femininity and thus allows for less flexibility of performance.

Sharps, Price, and Williams (1994), using a mental rotation task, found that giving instructions that did not label the task as a spatial task eliminated the sex difference. In other words, men performed better than women when subjects were told "This is a test of your spatial abilities." Under non-spatial instructions, ("This is a test of your reasoning and problem solving abilities"), there were no sex differences. Next, these researchers manipulated the gender connotations of the instructions. The task was presented as predictive of one's ability in either interior design or combat aircraft flying. As in the memory task described above (Herrmann, Crawford, & Holdsworth 1992), men were more affected than women by the manipulation. Men in the masculine instruction condition performed better than any other group, yielding an the interaction of subject sex and instructional condition rather than a "sex difference" as such.

In a dual-experiment study by Sharps, Welton, and Price (1993), materials and instructions were manipulated to observe potential gender-related effects in a spatial memory task. In the first experiment, women and men were told they would observe an array of objects on a table top. Their task was to remember what objects were located in which positions. There was no mention of "spatial memory." Half of the participants observed a simple map drawn on white paper with common objects (e.g., paper clip, light bulb) place in random locations. The other half of the participants observed a nonmap model consisting of wooden blocks of various shapes (e.g., cube, cylinder) placed on a piece of particle board. The two models were the same size and contained the same number of objects. The participants studied the model and then left the room for two minutes to perform a filler task. Upon return, the participant was handed each object and told to place it in its correct location. There were no main effects of sex, but there was a significant interaction of sex and model. As anticipated, women's performance was better than men's on the nonmap model and worse than men's on the map model. Men's performance was consistent across models. The results of this experiment suggest that sex

differences in spatial memory performance can be *reversed* by altering the demand characteristics of the task.

The second experiment used an abbreviated version of the Vandenberg-Kuse test. This block mental rotation task has produced significant sex differences in the past. Participants were given the standard instructions which do not mention "spatial abilities" or "spatial cognition." In addition, one short paragraph was added to each group's instructions. The paragraph either deemphasized ("This is a test of how people think about objects") or emphasized ("This is a test of spatial abilities") the spatial nature of the task. The men significantly outperformed the women when the instructions emphasized the spatial nature of the task (as the original Vandenberg-Kuse instructions do). However, when the spatial nature of the task was deemphasized, the sex difference was eliminated. Clearly, the women in this study were influenced by the *identification* of the task as a test of spatial abilities rather than by the task itself. It is likely that women learn that they are "not good at" spatial tasks and this belief leads to a self-fulfilling prophecy when faced with a task labelled "spatial." However, their actual performance when the same task is gender-neutralized is identical to that of men.

These results are intriguing, but not definitive. Richardson (1994) found no effect of task labeling in a similar situation. Sex differences favoring males were obtained regardless of task label, but effect sizes were smaller than for earlier student cohorts and largest for introductory-level students. Richardson argued that these fluctuating differences could best be explained as due to sociocultural factors.

Clearly, both men's and women's expectations about the gender typing of a cognitive task can affect their performance. Beliefs about differences, along with a desire to appear appropriately masculine or feminine, create ample opportunity for the development of self-fulfilling prophecies. For example, if an individual who believes that men are better at directions is talking to a man and a woman who are together at a party, he may choose to give directions to a new restaurant to the man. The man in this couple thus gets more practice in a spatial-visualization/spatial-memory task, and the woman gets the message that she is unlikely to do well at such tasks.

GENDERED EXPERIENCE WITH ACTIVITIES INVOLVING SPATIAL ABILITIES

There is evidence for a relationship between gender-typed social roles and spatial visualization. Nash (1975) assessed gender preference by asking sixth- and ninth-grade boys and girls whether they preferred to be their own or the other sex, then measured their performance on a spatial-visualization task. Male gender preference was positively related to spatial performance. In other words, boys who preferred to be boys scored higher than boys who preferred to be girls, and girls who preferred to be boys scored higher than girls who preferred to be girls.

There were few sixth-grade, and no ninth-grade, boys who preferred to be girls. Many girls, especially in the younger group, preferred to be boys. Children of both sexes who preferred to be boys did not differ in spatial performance. When asked

to explain their preference for being a boy, children of both sexes referred to the desirability of male activities such as sports and the high value placed on male roles in our society. Nash's study indicates that masculine attributes and preferences are a better predictor of spatial performance than sex itself—perhaps because those who prefer to be boys act like boys and get more practice in spatial-skill-related play.

Children are encouraged to play with different toys and engage in different activities from a very early age. Boys are given vehicles and building equipment and encouraged to build models from diagrams, construct forts and playhouses, and take apart and reassemble objects. They are more likely to be provided with science-related toys such as microscopes and puzzles. These toys may help them learn more about manipulating movement and space than the dolls and miniature housekeeping equipment provided for girls. Beliefs about the suitability of different toys for boys and girls have been remarkably resistant to change. A sample of white middle-class college students indicated that suitable toys for boys include Tinker-toys, doctor's kits, blocks, and model airplanes. Suitable toys for girls included a tea set, doll house, supermarket, and toy telephone. In addition to the gender typing of particular toys, there were fewer girls' toys than boys' toys (Miller 1987).

These gender distinctions have been related to later differences in spatial ability. In a review of research on the play patterns of children aged 3 to 13, Dyanne Tracy concluded that boys and/or children with a masculine gender orientation play with a wider variety of toys and also develop better spatial and mathematics skills than girls and/or children with a feminine gender orientation (Tracy 1987). In a study of preschoolers, girls and boys who preferred activities such as climbing, building with blocks, and playing with vehicles scored higher on a spatial-ability test than those who played with dolls and housekeeping toys (Serbin & Connor 1979).

Other activities that may affect spatial skills distinguish boys' and girls' play. The permissible play space for boys is greater; girls are kept closer to home while boys learn to navigate a neighborhood "territory" (Feiring & Lewis 1987). Some sports have strong spatial-skills components. Computers are stereotyped as masculine. Boys dominate video arcades and computer clubs; both games and educational software are designed with boys in mind (Kiesler, Sproull, & Eccles 1985). High school girls rarely enroll in classes of mechanical drawing, analytical geometry, or shop. Differential practice may also come from map-reading and tinkering with the car during spare time (Sherman 1967). Of course, a relationship between practice and skill does not prove that skill differences are caused by practice. It is possible that those with more aptitude or greater skill choose activities that allow them to practice spatial skills because they are enjoyable.

Effects of Training and Practice on Spatial Abilities. Exposure to computer learning opportunities may be a big factor in spatial ability development. In a recent study, Black and White children in the African nation of Zimbabwe were provided with the computer learning tool LOGO. Pretests and posttests showed that, compared to a group who were not exposed to computers, these children scored higher on a math scale of a standard intelligence test. In addition, Black girls showed large gains in spatial reasoning. Clearly, the cognitive development of these 11–12 year-olds,

especially the girls, was facilitated (Mundy-Castle, Wilson, Sibanda, & Sibanda 1989).

If spatial abilities are strongly affected by experience, it follows that specific training on spatial tasks should improve performance. Although hundreds of studies have documented the existence of gender-related differences, surprisingly few have investigated the role of training and practice. A meta-analysis exploring the role of experience and training in spatial skills recently showed that both general experience and specialized training are associated with better performance on spatial tests for both sexes (Baenninger & Newcombe 1989).

These studies clearly indicate the role of experience and practice in spatial skills. They suggest that researchers who want to test for gender-related differences should first match their male and female research participants on relevant background experiences rather than just matching for age or grade in school. Otherwise, a "sex" difference simply reflects the fact that sex is correlated with particular experiences (Hyde 1981). And of course the culture's provision of differential experience is not haphazard; it is connected to structural and institutional aspects of gender. The studies also suggest that one way to help young girls develop their cognitive abilities is to provide them with computers and "boys' toys." "We may be shortchanging the intellectual development of girls by providing them with only traditional sex stereotyped toys" (Halpern 1992, p. 215). To be effective, this strategy would also have to involve changing the gendered cultural meanings of those toys and activities.

MATHEMATICS ABILITIES

FACTORS INFLUENCING MATH ABILITIES

Girls' mathematics performance is better than boys' in the elementary school years, but by high school they have lost their early advantage in computational skill and perform similarly to boys. In problem solving, there are no consistent gender-related differences at any age (NAEP 1983). Just a relatively short time ago, when standardized tests were first being normed in the 1940s to 1960s, the differences were much larger and favored boys. Today, however, boys and girls do not differ at all in basic math skills (Feingold 1988). Contrary to beliefs that girls don't like math and are not good at it, many studies (summarized by Chipman & Wilson 1985) show that girls like math just as much as boys do and, through the intermediate high school level, perform similarly. There is, however, a well-documented gender-related difference favoring males in advanced mathematics performance. This difference shows up when scores on the PSAT (given to large representative samples of high school students) are compared to scores on the SAT (taken by self-selected college-bound students). The average gender-related difference on the PSAT is small, but boys are still disproportionally represented at the top end of the

scale. On the SAT the differences are much larger and the proportion of males at the top end of the distribution greater. Boys score an average of about 50 points higher on the math portion of the SAT than girls. Among the very highest scorers in two recent test administrations, boys earned 96% of perfect 800 scores, 90% of scores between 780 to 790, 81% of scores between 750 and 770, and 56% of scores of 600 (Dorans & Livingston 1987). Studies of mathematically precocious youth identified through national talent searches also show that far more boys than girls are identified as gifted, and the gifted boys score higher than the gifted girls (Benbow & Stanley 1980).

Girls start out liking math and believing that girls are better at it than boys (Boswell 1985). They do better than boys on standardized tests and get better grades in math (as well as in other subjects). Yet, by the time they are in high school, they score lower on advanced math skills. The development of this difference cannot be attributed to one or two isolated variables. Rather, there are many interacting factors that may be responsible. We will examine beliefs about math as a male domain and the possibility of sex bias in standardized tests, illustrating cultural level influences. Gendered interaction in the classroom illustrates the interactional level. Girls' confidence in their math abilities illustrates the individual level of gender effects. Finally, we will consider hypotheses about biologically based differences in ability, an illustration of sex (rather than gender) influences.

MATH AS A MALE DOMAIN

Consider for a moment the stereotype of a mathematician: a cerebral-looking middle-aged man with glasses and an intense but absent-minded air—an Einstein, or, perhaps, just a "nerd." Now visualize a woman mathematician. "Unattractive," "masculine," "cold/distant," and "unfeminine" are the negative stereotypes that women mathematicians perceive others to hold about them, along with "aggresive," "socially awkward," and "overly intellectual" (Boswell 1985). When elementary and senior high school students were asked about their perceptions of people in math-related careers such as science, engineering, and physics, they described men—who were white-coated loners, isolated in laboratories, with no time for family or friends (Boswell 1979). Children learn very early that math is a male domain. By the third grade, they believe that adult women are generally inferior to adult men in math (Boswell 1985).

In the past, it was thought that the belief that "math is for men" was held largely by girls and women, and that it deterred them from choosing math courses and math-related activities. However, a meta-analysis of math attitudes has shown that males hold this belief much more strongly than girls and women do (Hyde, Fennema, Ryan, Frost, & Hopp 1990). This finding is very interesting because it suggests that gender-related influences on math choices work at the interactional and social structural levels at least as much at the individual level. In other words, we cannot explain the under-representation of girls and women in math courses and math careers by saying that they mistakenly believe that math is for men, an intrapsychic or individual "attitude problem." Rather, if this belief is affecting girls

and women, it must be because boys and men hold it, and something in their behavior toward the girls and women they interact with puts subtle pressure on them not to achieve in math and science. Once again, research illustrates how conceiving gender as solely an attribute of individuals leads to simplistic analyses and recommendations. To understand gender, we must keep sight of the gender system.

The gender incongruence of math for girls is heightened by a lack of role models. Beyond junior high, math and science teachers are predominantly men. Very few girls learn about great women mathematicians such as Emmy Noether, who persisted in her research despite blatant sex discrimination and provided the mathematical basis for important aspects of relativity theory (Crawford 1981). Few young girls have opportunities to offset negative influences through personal contact with women mathematicians and scientists.

SEX BIAS IN TESTING

The purpose of standardized tests such as the SAT is to predict performance in college. But although women score lower on these tests, they get better grades than men in college. The tests thus under predict women's performance (Rosser 1987; Stricker, Rock, & Burton 1992). Testing activists have charged that a test that underpredicts the performance of more than half the people who take it should be considered consumer fraud (Rosser 1987, 1992). The consequences for women are serious. Nearly all four-year colleges and universities use test scores in admissions decisions. Because women's college grades are higher than their test scores predict, some women are probably being rejected in favor of male applicants who will do less well in college. Moreover, women lose out on millions of dollars in scholarships based on test performance. More than 750 organizations use test scores in awarding scholarships. Only about one-third of National Merit Scholarship finalists are female; proportions in other scholarship programs are similar (Sadker & Sadker 1994). In New York state, students can win Regents Scholarships for college. If these scholarships were awarded on the basis of grades, young women would win 55.5% of them; if SAT scores alone were used, young men would win 56.5%. When the state decided to change from SAT scores alone to use both criteria in 1990, young women won a majority of the awards for the first time in the program's 77-year history. Boys continue to win over 60% of the more prestigious Empire State Scholarships, which require higher SAT scores (Verhovek 1990). Young women also lose out on opportunities to participate in special programs for the gifted (we have already noted the overabundance of boys discovered in national talent searches in math). Finally, an individual's test scores affect her self-confidence and her future academic goals (Rosser 1992; Sadker & Sadker 1994). For all these reasons, sex bias in testing is an important issue.

Test publishers claim that the tests are not biased. They have acted to remove the more obvious biases uncovered in earlier studies. For example, Selkow (1984), in a review of 74 psychological and educational tests, documented that girls and women were under-represented and appeared in stereotyped roles. In math tests, items

tended to be set in contexts more familiar to boys, such as sports (Dwyer 1979). Along with measuring math ability, then, tests may have been inadvertently reflecting a bias toward male interests. Although standardized tests are supposed to be objective, they are written by subjective human beings who reflect the values of their society. Furthermore, test-takers bring to the test different feelings about themselves and the test, and thus interpret items differently. Given the importance of the decisions made on the basis of testing in our society, more research is needed on the tests themselves and how they produce similarities and differences among groups.

Another problem is the topics not defined as cognitive abilities by psychologists and testmakers. At least one testing specialist, Teitelbaum (1989), maintains that, from a feminist perspective, standardized tests are deeply androcentric in this regard:

> Excluded are whole areas of human achievement that contribute to success in school and work.... Such characteristics and skills as intuition, motivation, self understanding, conscientiousness, creativity, cooperativeness, supportiveness of others, sensitivity, nurturance, ability to create a pleasant environment, and ability to communicate verbally and nonverbally are excluded from standardized tests. By accepting and reflecting the androcentric model of knowledge, standardized tests reinforce value judgments that consider this model of knowledge more valid and important than other ways of viewing the world. Content that is not tested is judged less valuable than that included on tests (p. 330).

Gender in the Classroom. The single biggest influence on math performance is that girls take fewer math courses (Chipman & Thomas 1985). Math performance diverges only in high school, when girls begin taking fewer math courses. When course-taking is controlled, the differences nearly disappear (Chipman, Brush, & Wilson 1985). Math course-taking is becoming more equal; girls now take algebra and geometry nearly as much as boys, but still avoid calculus (Sadker & Sadker 1994).

Even when they take the same courses, boys and girls are experiencing different worlds in the classroom. Studies at all grade levels have shown that often a few males are allowed to dominate classroom interaction while other students are silent and ignored (Eccles 1989). Gender interacts with race to determine who gets attention from teachers: White males get the most attention, followed by minority males and White females. Minority females get the least attention of any group. Classroom interaction studies show that African-American girls become less active, assertive and visible in class as they move through the elementary grades (Sadker & Sadker 1994).

Girls are praised for their appearance, boys for their performance. Girls experience sexual harassment from their peers and teachers far more often than boys. Twenty years of research on educational equity has shown such a dismal pattern of deeply ingrained sexism that researchers Sadker and Sadker titled their 1994 book *Failing at Fairness: How America's Schools Cheat Girls*. In the voices of the young women they interviewed, the sexism, and its effects on bright girls, are evident:

> In my science class the teacher never calls on me, and I feel like I don't exist. The other night I had a dream that I vanished.
>
> People are always surprised to learn that I have a 4.0 and I'm a National Merit Finalist. Their image of me is "that blond girl who used to go out with Scott." Why can't they understand there's more to me?
>
> I have a teacher who calls me "airhead" and "ditz." I used to think I was smart, but now I don't know. Maybe I'm not. What if he's right? The more he treats me like an airhead, the more I think maybe I am (p. 135)

Gender inequity that can affect math and science performance extends to out-of-school educational experiences as well. Boys are more likely to participate in activities such as chess clubs, math clubs, summer computer courses, and science camps. In short, boys live in a math-enriched environment that encourages achievement, and girls in a math-impoverished one that encourages self-doubt.

LOW CONFIDENCE, LOW SELF-EXPECTATIONS

Given the structural and situational variables described above, it is not surprising that girls' lower confidence about their abilities is a consistent finding in many studies (Chipman & Wilson 1985), although meta-analysis shows that the difference is not large (Hyde, Fennema, & Lamon 1990). Moreover, girls' confidence in their abilities continues to be undermined. In 1992, the Mattel Corporation introduced Teen Talk Barbie, the first talking Barbie since the 1970s. Among the words they put in her mouth: "Math class is tough." Myra and David Sadker (1994) noted:

> The national flap over Barbie's "Math class is tough" faux pas is a symptom of the inroads females have forged in this formerly male preserve. The Washington Post dubbed the doll "Foot-in-Mouth Barbie," and the American Association of University Women warned that this was precisely the kind of role model girls did not need. Math teachers around the country registered their dismay. "We've been working so hard at closing the gender gap and fighting math anxiety for girls," an Illinois teacher told us. "This is the last thing we need" (p. 122).

By the time they are in junior high, girls are losing their early confidence that they can do math as well as or better than boys, and their change in attitude is independent of their actual performance. Although their grades remain better than boys' grades, girls rate themselves lower in math ability, consider their math courses harder, and are less sure that they will succeed in future math courses (Eccles et al. 1985). For eighth-graders, math confidence and attitudes toward success in math are more important in determining whether girls will take college preparatory math than are their actual math achievement scores (Sherman 1983). Among high school girls of equal ability, those who are less confident are more likely to discontinue math (Sherman 1982). Female college students are also less confident that they can do well in computer courses, and this attitude affects their course enrollment (Miura 1987). By the time they are in college, doing well in math is unrelated to women's

(but not men's) feelings of overall competence (Singer & Stake 1986). For many young women, math changes from a valued skill to something that is "just not me."

Parents of girls probably play a part in these attitude changes. Parents attribute a daughter's success in math to hard work and effort, and a son's success to natural *talent*. They view math as more difficult for daughters than for sons, and they believe that math, especially advanced math, is more important for sons. Parents, then, provide an interpretive framework for their sons' and daughters' beliefs about their abilities (Eccles 1989). Boys learn that they have natural talent in an important area, and girls learn that hard work cannot wholly compensate for their lack of ability!

Biological Influences. Some psychologists believe that the persistent differences in mathematics achievement reflect biological influences. As noted earlier, boys are much more likely than girls to be identified as gifted in national math talent searches. Based on this evidence, Benbow and Stanley (1980) concluded that "Sex differences in achievement and in attitude toward mathematics result from superior male mathematical ability which may, in turn, be related to greater male ability in spatial tasks" (p. 1264). Although they had not investigated biological variables in any way, they suggested that biology was at the root of the difference because environmental factors were equated: their (junior high) boys and girls had taken the same number of formal math courses. Over-generalization and a rush to "biologize" results are unfortunately frequent in research on gender-related differences. We have described many sociocultural factors which have been shown to affect math attitudes and performance. As mathematics professors Alice Schafer and Mary Gray (1981) point out, environmental factors were not ruled out in Benbow and Stanley's study:

> Anyone who thinks that seventh-graders are free from environmental influences can hardly be living in the real world. While the formal training of all students may be essentially the same, the issues of who helps with mathematics, of what sort of toys and games children are exposed to, of what the expectations of parents and teachers are, and of a multitude of other factors cannot lightly be set aside (p. 231).

More recently, Benbow (1988) has reviewed evidence for environmental and biological factors and again concluded that "sex differences in extremely high mathematical reasoning ability may be, in part, physiologically determined" (p. 182). Many other researchers have also suggested that biological differences in spatial ability are related to math performance. It seems plausible that some kinds of math—for example, geometry—require a spatial-skill component. But there is no conclusive evidence for a biological basis for gender-related differences in spatial skills. The existence of a sex-linked gene for math ability has been ruled out (Sherman & Fennema 1978). Furthermore, several reviewers have concluded that there is no evidence that differences between girls and boys in spatial ability can account for their differences in math performance (Chipman, Brush, & Wilson 1985; Linn & Petersen 1986). And even among boys identified as gifted in math and

science, the majority do not pursue math and science careers. Clearly, ability alone does not determine intellectual growth and career choice.

Possible connections between biological influences such as genetics or hormones and intellectual performance continue to be explored. One indication of the controversy and interest this line of research generates is that 42 researchers chose to respond with written commentaries to Benbow's 1988 article, with a spectrum of opinions about the issues. We would simply caution researchers not to be hasty in affixing biological interpretations to what may be only the individual residue of a pervasive gender system in action.

Although there is no reason to believe that biologically-based differences are any more immutable than socially produced ones, the cultural context of interpretation is relevant. Claims about biological differences occur in a social context of gender inequality and may become part of the self-fulfilling prophecy of gender. Ironically, Benbow and Stanley (1980) may have indirectly (and inadvertently) contributed to the sociocultural causes of math deficits in girls and women. Their article, published in *Science*, was seized on by the popular press and reported in highly misleading stories and headlines such as "Study suggests boys may be better at math" and "Do males have a math gene?" Eccles and Jacobs (1986) conducted a field study comparing the attitudes of parents who had heard about the article with those who had not. (Because Eccles's research on math attitudes and performance was underway at the time, she had a sample of parents whose attitudes toward their daughters' abilities she had already measured.) Reading about "scientific evidence" for a "math gene" favoring boys led mothers of daughters to lower their estimates of their daughter's abilities. We have already noted the importance of parents in providing an interpretational framework for their children's self-assessments.

SEX DIFFERENCES AND SOCIAL POLICY

We have seen that research about gender-related differences is often distorted in press reports, and these reports have very real effects on girls and their parents (Beckwith 1984; Eccles & Jacobs 1986). Hypotheses about female inferiority, like the proverbial bad penny, seem to keep turning up, despite lack of evidence (Shields 1975, 1982). Rather than expend further research effort on documenting differences, many feminist psychologists have proposed alternative approaches. These include suggestions that psychologists study exceptions to the average, such as girls with very high spatial abilities, and determine what experiences have influenced them and what cognitive strategies they use (Halpern 1986); focus on how to equalize opportunity for girls (Hyde & Linn 1986); or explore the social causes of differences (Unger 1979; Unger & Crawford 1996).

Gender-difference issues are particularly difficult for psychology to deal with, since they depend more on interpretation of the evidence than on the evidence itself. The practice of drawing implications and making policy decisions on the basis of

these data introduces further dangers. When a gender-related difference is thought to disadvantage boys, compensatory action is taken. This is less likely to occur when a difference is thought to disadvantage girls.

Consider for a moment the widespread belief that girls excel at verbal task and boys at mathematical tasks. Because it has been believed that boys' poorer verbal abilities make it more difficult for them to learn to read, most elementary textbooks and children's literature are specifically designed to appeal to boys and help them overcome their difficulties. Scott O'Dell, author of the prize-winning children's book *Island of the Blue Dolphins*, has described how he was asked by publishers to change his main character from a girl to a boy. A 1980 teacher education book suggests that the ratio of "boy books" to "girl books" in the elementary school classroom should be 2 to 1 (Segel 1986). Standardized tests may also be designed to appeal to boys and men. In 24 recent SAT reading comprehension passages, 34 famous men and only one famous woman were named (Rosser 1987).

Further, little effort is expended in a search for a "verbal-abilities gene" or other biological determinants of the difference. Nor is the difference seen as a problem for boys in everyday life. There are few books for boys or men on "How to Improve Your Vocabulary and Get Ahead," "Overcoming Verbal Anxiety," or "How to Talk to Your Wife." Instead, women are encouraged to compensate for men's supposed inability to express themselves, by drawing them out in conversation and by accepting their limitations with grace and understanding (Gray 1992; Tannen 1990). Finally, gender-related differences are not seen as limiting boys and men's occupational options. It would seem ludicrous for a small average difference in verbal skills to imply that boys could not become successful writers, trial attorneys, English professors, or politicians.

When a gender-related difference favors boys, however, a different story unfolds. Consider mathematics achievement. Textbooks and other learning and testing materials remain male-oriented, with problems more likely to have male characters and to be framed in terms of topics likely to interest more boys and men. One widely used test of problem-solving employs eight times as many male as female actors in the problems (Johnson 1984). Further, there is a tendency to "biologize" the difference in spite of there being no evidence for a "math gene." Men are not encouraged to devise ways to help their women friends improve their mathematics abilities. Instead, women are encouraged to work at overcoming their own "math anxiety." Finally, the average difference is used to explain women's relative absence from certain math related occupations such as engineering, even though the gender-related difference is much too small to account for the fact that only about 3% of engineers are women. Indeed, it seems that the social meaning of a group difference depends on the social position of the "deficient" group (Unger & Crawford 1996).

We have conceptualized gender as a system operating at three levels in order to provide a heuristic for examining gender effects on cognition in social context. We hope that it will foster thinking across disciplinary boundaries. Gender at the social structural level has traditionally been the province of sociolinguistics, sociology, anthropology and mass communication studies, while the interactional level has been encompassed by social psychology and interpersonal communication studies

and the individual level by clinical, developmental and personality psychology. In studying cognition in context, each researcher will probably choose to focus on one level, but it is best to keep sight of the system as a whole. Moreover, we hope that conceptualizing gender as a social system will help researchers recognize that they share conceptual and methodological concerns with those attempting to understand other systems of social stratification such as age, race, sexuality, and class. The adequacy of the answers we find depends on the sophistication of the questions we ask, and the social consequences of our investigations are enormous.

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